

REMARKS/ARGUMENTS

Claims 15-16 have been canceled. Claims 17-19 have been withdrawn. Claims 21-22 have been added. Claim 1 has been amended. Claims 1-14 and 20-22 are pending.

The Examiner rejected claim 20 under 35 U.S.C. 112, first paragraph. The Examiner stated that it was unclear where in the specification teaches the limitation of claim 20. The limitations of claim 20 are disclosed on page 22, lines 25-29, of the present application.

The Examiner rejected claims 1-8, 11, 13 and 20 under 35 U.S.C. 103(a) as being unpatentable over Chu et al. (US 6,616,253 hereinafter Chu and admitted prior art (APA)).

In the response to arguments on page 5 of the final rejection, the Examiner stated that features upon which the applicant relies were not recited in the rejected claims. Claim 1 has been amended to more clearly recite these limitations, that the forming of protective sidewalls prevents faceting and fence formation so that the etching the trench etches the trench with reduced faceting and fence formation.

It would not be obvious to combine Chu and APA to obtain the invention as recited in claim 1, as amended. There is no expectation of success that the etch process of forming contact holes described in Chu would successfully be used in APA to form trenches after vias had already been formed, which reduces the faceting and formation of fences described in APA. Page 7, line 19, to page 8, line 7, of the current application describes how in a via first formation without a trench stop layer, corners at the top of the vias and bottom of the trenches are faceted, as shown in FIG. 11B with facets 1172. The Examiner failed to point out anything in Chu or APA that would teach or suggest that the process of Chu when applied to form a trench when vias are first formed would prevent such faceting. APA and Chu do not teach or suggest that Chu would prevent faceting at a bottom of a trench feature being etched by Chu.

In addition, the Examiner stated that Chu doesn't describe forming vias, but that the APA teaches forming contact holes. The applicants' agent contends that Chu fails to teach etching trenches but only teaches etching contact holes, which are vias. The last sentence of the abstract of Chu states that the process of Chu is for forming contact holes, which are vias, not trenches

which are not contact holes. The Examiner stated that trenches are contact holes because they are formed for contacting purposes of interconnects. As used in the present application, trenches 1456 are features that are etched only partially through a dielectric layer 1420, as shown in FIG. 14E. Since trenches are not etched completely through a dielectric layer they do not make contact with the conductive material 1404, 1406 under the dielectric layer 1420. Instead, vias (or contact holes) 1440, 1444, FIG. 14A, are etched completely through the dielectric layer 1420 to form a contact with the underlying conductive material 1404, 1406. As shown in FIG. 14A a temporary partial plug 1448 is formed to protect the barrier layer 1412. The partial plug 1448 is removed and the barrier layer is etched to complete the vias. Likewise in Chu, FIG. 18 shows a completed contact hole 222, col. 11, lines 38-43, which is etched complete through the dielectric film 220 to the underlying conductive layer 210. Therefore, the conductive holes of Chu are the same as the vias of the present application. For at least these reasons, the trenches described and claimed in the present application are not contact holes. For at least these reasons, claim 1, as amended, is not made obvious by Chu and APA.

The Examiner rejected claim 12 under 35 U.S.C. 103(a) as being unpatentable over Chu, admitted prior art, and Tang (US 6,211,092).

The Examiner rejected dependent claims 9-10 under 35 U.S.C. 103(a) as being unpatentable over Chu and admitted prior art, in further view of Bhardwaj et al. (US 6,051,503).

The Examiner rejected dependent claim 14 under 35 U.S.C. 103(a) as being unpatentable over Chu and admitted prior art, in further view of Hussein et al. (US 6,406,995).

Dependent claims 2-14 and 20 are also patentably distinct from the cited references for at least the same reasons as those recited above for the independent claim, upon which they ultimately depend. These dependent claims recite additional limitations that further distinguish these dependent claims from the cited references. For example, claim 9 further recites that the deposition step uses a mixture of CF₄ and H₂. The Examiner cited Bhardwaj et al. as teaching the use of H₂ as a diluent. Col. 5, line 33, of Bhardwaj et al. teaches that H₂ is a diluent for H-C precursor, not CF₄. Bhardwaj et al. teaches that the H-C precursors are for example CH₄, C₂H₄, C₃H₆, C₄H₈, C₂H₂ (col. 4, line 2, of Bhardwaj). Therefore, a gas of CF₄ and H₂ is not disclosed or made obvious.

In addition, claim 10 recites specific flow ratio ranges of CF₄ to H₂. Nothing in the cited references discloses or makes obvious this recited range.

In addition, claim 12 further recites that the etch layer is a low k dielectric. Although Tang discloses an etch layer that is a low k dielectric, Tang does not remedy the above described deficiency of Chu. In addition, Tang requires a trench stop layer 16, FIG. 15, of Tang. Therefore, it would not be obvious to combine the teachings of Chu, Tang, and APA to obtain a process of etching trenches in a via first process, since there is nothing to suggest a probability of success.

In addition, claim 13 recites that the via holes are not filled with a sacrificial material prior to the start of the trench plasma etching process. The Examiner stated that Chu doesn't show a sacrificial filler material in the via holes prior to the start of the trench plasma process. The Examiner failed to point out anything in Chu that states that Chu shows via holes prior to the trench plasma process. As discussed above, Chu does not teach a trench plasma process; therefore, Chu could not teach not having a sacrificial filler material prior to the start of the trench plasma process. For at least these reasons, claims 2-14 and 20 are not anticipated or made obvious by the cited references.

Claims 21 and 22 have been added to recite that the etch layer is a low k dielectric layer without a trench stop layer. This is shown as 420 in FIG. 14A and described on page 25, lines 22-27.

Applicants believe that all pending claims are allowable and respectfully request a Notice of Allowance for this application from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at telephone number (650) 961-8300.

Respectfully submitted,
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